

# ABANDONED MINE DRAINAGE

## *Overview*

The headwaters of the Schuylkill River are located in the serene mountain valleys of Schuylkill County, Pennsylvania. An area rich in scenic beauty and coal mining history, the Little Schuylkill and Upper Schuylkill Rivers are designated cold-water fisheries, and the Schuylkill main stem is a State Scenic River at the confluence of these two tributary waterways.

Abandoned Mine Drainage (AMD) is the primary cause of pollution in the Schuylkill River headwaters and the biggest source of metals downstream. AMD is created deep below the ground in abandoned mines where streams, groundwater, and stormwater fill tunnels that were once kept dry by active pumping operations. Water and oxygen react with lingering iron sulfide (pyrite) producing metal-laden and sometimes highly acidic discharges that exit the tunnels in telltale orange and silver plumes, easily visible in these regional surface waters.



*Abandoned mine discharge*





*Abandoned mine tunnel*



*Passive AMD treatment system*

AMD interferes with vegetative growth and reproduction of aquatic animals by armoring the streambed with deposits of iron and other metals. Acidity and metals impair both surface and ground drinking water resources and quickly corrode pipes and industrial mechanisms. Unattractive waterways marred by AMD can hinder tourism and recreational opportunities like fishing, boating, and swimming that attract so many people to visit, vacation, and reside in this region.

AMD treatment is expensive, but so is the economic and environmental damage that results from untreated AMD. The Schuylkill Action Network (SAN) AMD Workgroup was formed to provide support and coordination among partners working to address AMD. Using Schuylkill Watershed Initiative Grant funding, the Schuylkill Headwaters Association, the Schuylkill Conservation District, the United States Geological Survey, and the Pennsylvania Department of Environmental Protection, with support from the Philadelphia Water Department, Aqua Pennsylvania, and the United States Environmental Protection Agency, have implemented innovative projects. These projects use both anoxic and oxic limestone drains, retaining basins, and/or wetlands to greatly reduce AMD flow by thousands of gallons per minute into the Schuylkill headwaters. By decreasing acidity and iron sedimentation in this precious water resource, these projects will restore and protect aquatic habitats, and ensure eco-based economic security and recreational enjoyment for present and future generations.

*The Schuylkill Watershed Initiative Grant is a \$1.15 million targeted watershed grant awarded by the U.S. Environmental Protection Agency for the completion of a suite of water quality improvement demonstration projects. The grant is administered by the Partnership for the Delaware Estuary and the Philadelphia Water Department, and through leveraging, provided \$3 million for water quality improvements, including over \$1.2 million devoted to AMD projects in the Schuylkill River Watershed.*



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## *Pine Knot Tunnel Study*

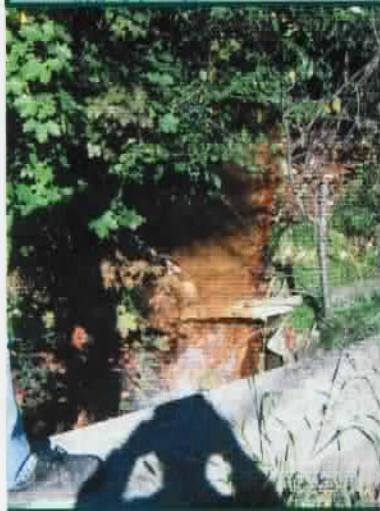
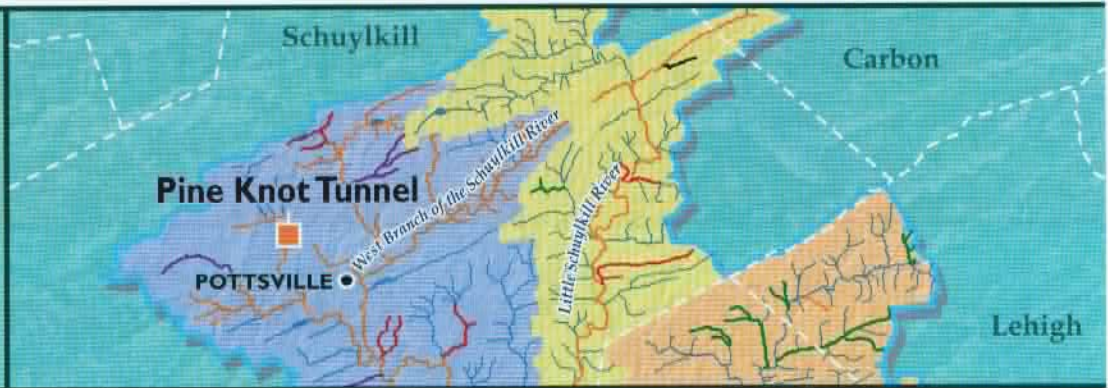


The focus of the Pine Knot Tunnel project is a large land-study area of approximately 20 square miles. Underlying this area, a huge network of tunnels spills 35-million gallons of Abandoned Mine Drainage (AMD) daily into the Schuylkill River headwaters. Much of this spillage originates from stormwater seeping into the mine system through fractures in the surface above.

Keeping water out of the tunnels is a key focus of the Pine Knot Tunnel Study. Pits in the ground surface that drain to the underground mine system have been located and mapped. Filling these pits and diverting stream flow away from them will keep a significant amount of fresh surface water from entering the system and becoming contaminated with AMD. The challenge is being able to fill enough surface pits to significantly reduce the discharge from the Pine Knot Tunnel system. The collaborative study resulting from this project serves as a valuable tool in determining which sites provide project opportunities that will yield the best possible outcomes.

During the course of the Pine Knot Tunnel Study, the United States Geological Survey (USGS) discovered through its monitoring that another nearby AMD source, Oak Hill, was contributing higher metal outputs at lower flow rates than the Pine Knot system, making it a better treatment site. Combined, the Pine Knot and Oak Hill discharges contribute 30% of all metals from approximately 100 AMD sources in the Schuylkill River Watershed.





Utilizing funds from the Schuylkill Watershed Initiative Grant, the Pine Knot Tunnel project provides a conceptual design and feasibility study for remediation and mitigation of water pollution attributed to AMD at a collection of sites. Potential project areas have been identified, and some treatment and diversion project designs have already been completed. As part of the study, the USGS has been monitoring flow and hydrology to provide critical insight about how the Pine Knot Tunnel system actually drains. This monitoring will continue beyond the study period.



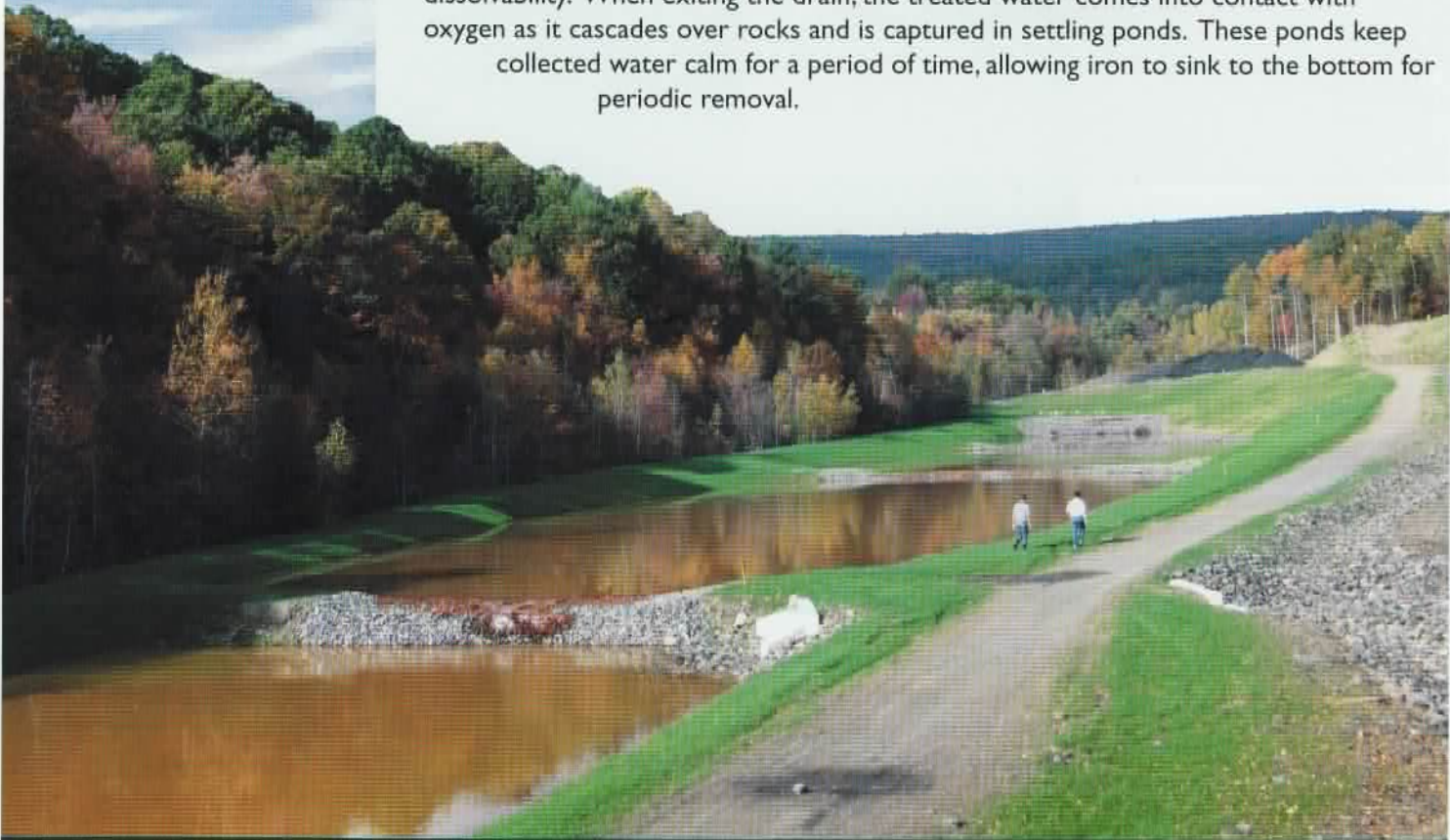
*The Schuylkill Watershed Initiative Grant is a targeted watershed grant awarded by the U.S. Environmental Protection Agency for the completion of a suite of water quality improvement demonstration projects in the Schuylkill River Watershed. The Pine Knot Tunnel Study project is one of more than 40 projects that received funding from this source, in addition to other funds and/or support. The grant is administered by the Partnership for the Delaware Estuary and the Philadelphia Water Department.*

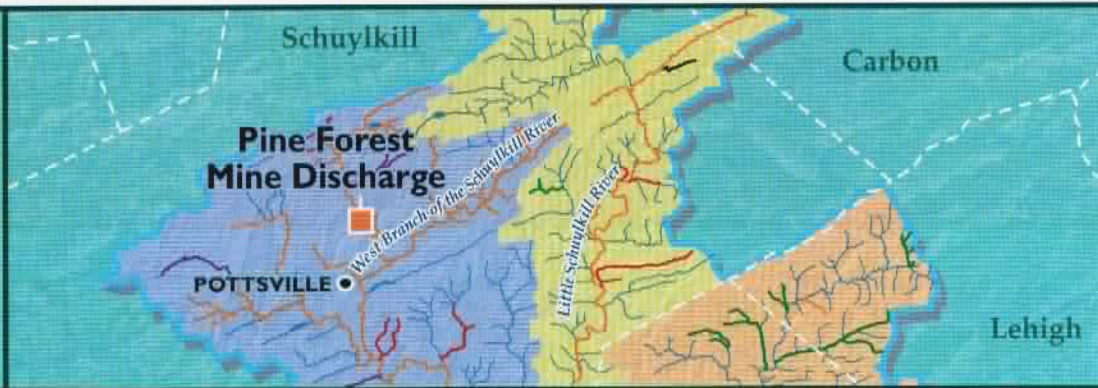
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## *Pine Forest Project*

Abandoned Mine Drainage from the Pine Forest Mine formerly discharged aluminum, iron, manganese, and acidity into Mill Creek, a Schuylkill River headwaters tributary. Using funds from the Schuylkill Watershed Initiative Grant, an anoxic limestone drain (ALD) was installed at this site by the Schuylkill Headwaters Association. The ALD neutralizes acid and removes up to 316-lbs of iron per day from the Schuylkill River.

ALD's are basically buried ditches of limestone. As mine water flows through the drain, the limestone dissolves and increases the alkalinity and pH levels. Water treated in this way needs to be anoxic, meaning it contains very little dissolved oxygen. Otherwise, iron hydroxides form and ultimately clog the drain. An ALD is buried under a clay cap, keeping oxygen out and trapping carbon dioxide, which increases the limestone's dissolvability. When exiting the drain, the treated water comes into contact with oxygen as it cascades over rocks and is captured in settling ponds. These ponds keep collected water calm for a period of time, allowing iron to sink to the bottom for periodic removal.





Treated water from the Pine Forest project is released into Mill Creek with significantly reduced metals and a healthier pH level. Sections of the Schuylkill headwaters are designated cold-water fisheries, meaning improved water quality in smaller tributaries such as Mill Creek creates a healthier ecosystem to support stocked and natural trout populations. Healthy waterways encourage a robust aquatic recreational tourism industry, and improve overall quality of life in the region.



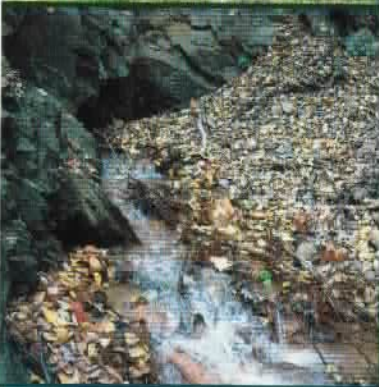
The Schuylkill Watershed Initiative Grant is a targeted watershed grant awarded by the U.S. Environmental Protection Agency for the completion of a suite of water quality improvement demonstration projects in the Schuylkill River Watershed. The Pine Forest project is one of more than 40 projects that received funding from this source, in addition to other funds and/or support. The grant is administered by the Partnership for the Delaware Estuary and the Philadelphia Water Department.

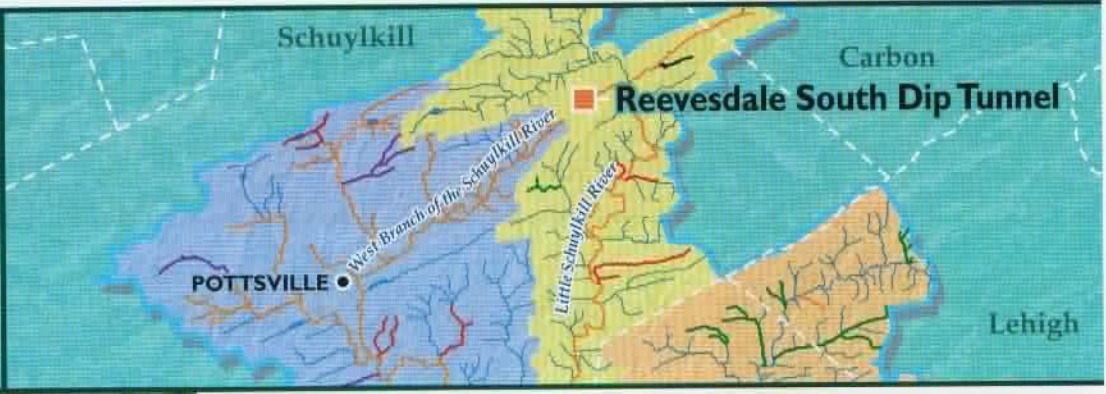
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## *Reevesdale South Dip Tunnel*

The Oxidized Limestone Drain (OLD) system installed at the Reevesdale South Dip Tunnel treats approximately 900-gallons per minute of Abandoned Mine Drainage (AMD) that would otherwise flow directly into Wabash Creek, a tributary of the Little Schuylkill River in Schuylkill County. The OLD, along with two wetland ponds installed by the Schuylkill Headwaters Association and funded by the Schuylkill Watershed Initiative Grant, reduces aluminum, iron, manganese, and acidity in these waters.

OLD's are buried limestone ditches into which oxygen-rich AMD waters are directed. AMD water flows into the OLD and dissolves limestone, which increases the alkalinity and pH levels of the water. Oxygen in the AMD water causes iron hydroxides to form and clog the system, therefore, OLD systems need to be flushed regularly. Water flushed from the drain is held in the wetland retention ponds until metals collect at the bottom for subsequent removal.





Despite the installation of a flush pipe network, effectiveness of the Reevesdale South Dip Tunnel project began to decrease not long after its installation due to accumulations of metals in the limestone bed. In the disastrous floods of 2006, the overwhelmed system failed completely, requiring extensive repairs in 2008. The repaired system will include a reconfigured water-flow path to increase exposure to the limestone surface and decrease the clogging potential. AMD treatment systems are a new technology that requires tailoring to individual site characteristics. The lessons learned from the Reevesdale system provide important information for future AMD design and installation.

Sections of the Schuylkill headwaters are designated cold-water fisheries, meaning improved water quality in smaller tributaries such as Wabash Creek creates a healthier ecosystem to support stocked and natural trout populations. Healthy waterways encourage a robust aquatic recreational tourism industry, and improve overall quality of life in the region.



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